

CLAIMS

What is claimed is:

1. A solenoid assembly, comprising:

a) a unitary, one-piece housing comprised of encapsulant,

b) an electromagnetic device completely encompassed by and embedded in the encapsulant, the electromagnetic device including:

i) a bobbin and coil subassembly, the bobbin having a central cavity and circumscribing a central axis and the coil wound around the bobbin, and an opening in the housing into the central cavity for receipt of a valve;

ii) terminal means electrically connected to the coil;

iii) a yoke surrounding the subassembly; and

iv) a flux plate with an opening into the central cavity, the flux plate electrically connected to the yoke and electrically insulated from the coil such that a flux gap is provided between the coil and yoke;

c) lead wires having one end embedded in the encapsulant and electrically connected to the terminal means; and

d) a hollow conduit having one end thereof embedded in the encapsulant and receiving and enclosing the lead wires, and having a distal end, free of encapsulant;

whereby upon energization of the coil by a current applied to the lead wires, electromagnetic forces generate a magnetic field within the central cavity for movement of a valve member.

2. The solenoid assembly as in claim 1, wherein the lead wires extend the length of the conduit and project outwardly from the distal end of the conduit, and further including a connector assembly at the distal end of the lead wires exterior to the conduit for connecting the solenoid assembly to a current source.

1 3. The solenoid assembly as in claim 1, further including an insulating plug located
2 within the conduit at the one end thereof, the lead wires extending through the insulating
3 plug.

1 4. The solenoid assembly as in claim 3, wherein the insulating plug includes a
2 circular plug portion sealing the one end of the conduit, and a flat support portion
3 disposed along the flux plate, and between the flux plate and the lead wires and terminal
4 to electrically insulate the lead wires and terminal means from the flux plate.

1 5. The solenoid assembly as in claim 4, wherein the support portion of the insulating
2 plug is embedded in the encapsulant.

1 6. The solenoid assembly as in claim 4, wherein the support portion includes a
2 trough extending from the plug portion to the terminal means, and the lead wires are
3 received and arranged in the trough.

1 7. The solenoid assembly as in claim 3, wherein the insulating plug is plastic.

1 8. The solenoid assembly as in claim 1, wherein the encapsulant is a non-magnetic,
2 moldable material.

1 9. The solenoid assembly as in claim 8, wherein the encapsulant is a thermoplastic or
2 thermoset epoxy.

1 10. The solenoid assembly as in claim 1, wherein the flux plate includes a second
2 opening closely receiving and supporting the conduit.

1 11. The solenoid assembly as in claim 1, wherein the conduit extends parallel to the
2 central axis of the assembly.

1 12. The solenoid assembly as in claim 1, wherein the housing is the outermost
2 container for the electromagnetic device.

1 13. The solenoid assembly as in claim 1, further including a flux bushing closely
2 received in the central cavity of the subassembly to concentrate magnetic flux in the
3 central cavity.

1 14. A solenoid assembly for a valve, comprising:

2 a) a unitary, one-piece housing comprised of non-magnetic encapsulant,

3 b) an electromagnetic device completely encompassed by and embedded in the
4 encapsulant, the electromagnetic device including:

5 i) a bobbin and coil subassembly, the bobbin having a central cavity and
6 circumscribing a central axis and the coil wound around the bobbin,
7 openings in the housing into the central cavity, and the central cavity of the
8 bobbin dimensioned to receive a portion of the valve;

9 ii) terminal means electrically connected to the coil;

10 iii) a yoke surrounding the subassembly with a first opening at one end of
11 the bobbin into the central cavity; and

12 iv) a flux plate with a second opening at another end of the bobbin into the
13 central cavity, the flux plate electrically connected to the yoke and
14 electrically insulated from the coil such that a flux gap is provided
15 between the coil and yoke;

16 c) lead wires having one end embedded in the encapsulant and electrically
17 connected to the terminal means;

18 d) a hollow conduit having one end thereof embedded in the encapsulant and
19 receiving and enclosing the lead wires, and having a distal end, free of encapsulant; and

20 e) an insulating plug at the one end of the conduit, with the lead wires extending
21 through the plug and the plug electrically insulating the lead wires and terminal means
22 from the flux plate;

23 whereby upon energization of the coil by a current applied to the lead wires,
24 electromagnetic forces generate a magnetic field which can be transmitted to an armature
25 in the valve portion.

1 15. A valve assembly, comprising:

2 a valve;

3 a solenoid assembly for actuating said valve, the solenoid assembly including a
4 unitary, one-piece housing comprised of encapsulant, an electromagnetic device
5 encompassed by and embedded in the encapsulant, the electromagnetic device including:

6 i) a bobbin and coil subassembly, the subassembly circumscribing a
7 central axis and having a central cavity receiving the valve through an
8 opening in the housing;

9 ii) terminal means electrically connected to the coil;

10 iii) a yoke surrounding the subassembly; and

11 iv) a flux plate with an opening into the central cavity with the valve
12 projecting through the opening, the flux plate electrically connected to the
13 yoke and electrically insulated from the coil such that a flux gap is
14 provided between the coil and yoke;

15 lead wire means having one end embedded in the encapsulant and electrically
16 connected to the terminal means; and a hollow conduit having one end thereof embedded
17 in the encapsulant and receiving and enclosing the lead wire means;

18 whereby upon energization of the coil by a current applied to the lead wire means,
19 electromagnetic forces generate a magnetic field which can be transmitted to the valve to
20 move a valve member in the valve.

1 16. The solenoid assembly as in claim 15, wherein the wire means extends the length
2 of the conduit and project outwardly from the distal end of the conduit, and further
3 including a connector assembly at the distal end of the wire means exterior to the conduit
4 for connecting the solenoid assembly to a current source.

1 17. The solenoid assembly as in claim 15, further including an insulating plug located
2 within the conduit at the one end thereof, the wire means extending through the insulating
3 plug.

1 18. The solenoid assembly as in claim 17, wherein the insulating plug includes a
2 circular plug portion sealing the one end of the conduit, and a flat support portion
3 disposed along the flux plate, and between the flux plate and the wire means and terminal
4 to electrically insulate the wire means and terminal means from the flux plate.

1 19. The solenoid assembly as in claim 18, wherein the support portion of the
2 insulating plug is embedded in the encapsulant.

1 20. The solenoid assembly as in claim 18, wherein the support portion includes a
2 trough extending from the plug portion to the terminal means, and the wire means are
3 received and supported in the trough.

1 21. The solenoid assembly as in claim 17, wherein the insulating plug is plastic.

- 1 22. The solenoid assembly as in claim 15, wherein the encapsulant is a moldable,
2 non-conductive material.
- 1 23. The solenoid assembly as in claim 22, wherein the encapsulant is a thermoplastic
2 or thermoset epoxy.
- 1 24. The solenoid assembly as in claim 15, wherein the flux plate includes a second
2 opening closely receiving and supporting the conduit.
- 1 25. The solenoid assembly as in claim 15, wherein the conduit extends parallel to the
2 central axis of the assembly.
- 1 26. The solenoid assembly as in claim 15, wherein the housing is the outermost
2 container for the electromagnetic device.
- 1 27. The solenoid assembly as in claim 15, further including a flux bushing closely
2 received in the central cavity of the subassembly to concentrate magnetic flux in the
3 central cavity.